Art. VI.—*Glaciation of the Western Highlands, Tasmania.*

(With Plate VIII.)

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During the month of October, 1892, professional work took me to the high rugged region surrounding Lake Dora, and there I had the satisfaction of discovering glaciation in its various developments and on an extensive scale. The salient features were made known at the time through the press, but as further particulars may be acceptable, a sketch plan has been drawn of the locality, and further data are appended.

Position, etc.

Lake Dora lies in a direct line about due east from the township of Zeehan and twelve miles distant, but the track between the two points is quite twenty-five miles long, and very difficult to traverse. Lake Dora is about 2,500 feet above sea level. The high tract of country over which glaciation occurs is shown on the plan on the smaller scale, the area more carefully examined is shown on the larger scale plan.

Geology.

This region is occupied by two principal rock formations, the older or schistose series is usually highly inclined, consisting of arenaceous, argillaceous and conglomerate schists; the schists are covered unconformably by massive sandstones, quartzites, cherty and quartzose conglomerates, belonging, apparently, to the Devonian age and corresponding to the Devonian conglomerates of Victoria. Most of the hills and ridges on the highlands are of the Devonian series, the schists occupying the hollows and valleys. The schist appears to be more readily worn down than the Devonian beds, hence most of the tarns appear to be on the former rock, or rather scooped out of it.

Physical Aspect.

The whole region consists of rugged rock-strewn mountains bare, except where sheltered sites have encouraged a forest growth; tarns are dotted about at many different altitudes, from the tiniest pools up to lakelets some miles in length. There is an absence of level land except where a small valley or tarn has been filled with peaty soil, on which the "button-grass" flourishes. Altitudes range from 1,800 to 3,800 feet above sea level over this tract.

Moraines.

The first evidence met with of glacial action was at the outlet of the gorge, where Lake Rolleston stands; this is an excellent example of a terminal moraine. From the level of the lake the morainal matter rises to an elevation of 150 feet on the east side, and for 250 feet on the west side, the whole consisting of a confused mass of angular, sub-angular and partly rounded boulders and blocks from a few pounds to masses of more than 100 tons in weight; this extends over several hundreds of acres. Enormous blocks project above the mass at intervals, while the east edge of the moraine is fringed with a very remarkable curved line of giant stones; they commence at the large one named "The Scout" on the plan, and they fringe the moraine for considerably more than half a mile, running in a northerly direction. Feeders to the glacier of which this moraine is the relic came in further northward from the country to the west and north-west of Lake Rolleston, and morainal matter occurs as marked on the plan. It would appear as though the glacier did not extend much further down the valley, but as though the end of the glacier became melted where the morainal matter now stands, and this continuing for ages caused the enormous accumulation of rocky material to take place. The whole of the moraine apparently consists of *débris* from the hills west of the lake (Rolleston), and is very largely made up of cherty conglomerate (Devonian). An examination of the individual blocks shows that one or more sides have been subjected to a planing action by which this intensely hard pebble-studded rock has been worn down and sometimes even polished. Portions

of the moraine consist of stones and blocks thrown loosely together, the interstices open; in other portions, the interstices are filled with fine material.

Another well marked moraine extends in a southerly direction from Lake Ruby (a small tarn in a gorge under a precipice 280 to 300 feet in height) down the course of Limestone Creek. The material, arrangement, etc., are very similar to that of the Lake Rolleston moraine. In both cases the surface of the moraine is of the most rugged nature.

Erratic Blocks.

Scattered over the surface all round Lake Dora on the hill sides, and even on the tops of hills 300 feet above the level of that lake, are blocks of stone, from small boulders up to heavy masses many tons in weight, that have been transported, in some cases, for miles by ice from their former sites to their present positions; all the morainal matter was thus transported. Some of the more conspicuous examples have been especially named on the plan. Scarcely any of them, but if carefully examined, show unmistakable evidence of having been ground, planed, striated, or polished on some portion of their surfaces. There is a great sameness of material, all of which is local and derived within a very few miles' distance. Some of the large blocks have been split since they reached their present position. Odd blocks of hornblendic rock occur of small size, they probably are derived from masses intruded through the Devonian rocks. Many of the erratic blocks are of great size, and some probably weigh hundreds of tons.

Planing, Scoring, and Polishing.

Planed and scored surfaces are features inseparable from glacial action, and these are most abundantly present over this region. On the western side of Lake Dora the rocky hillocks are planed down, scored, and striated in a beautiful manner, and right up the valley westward from Lake Dora this same action is exemplified on the rounded dome-like rocky projections of schist. To the east of Lake Dora, at the site marked on the plan, there are splendid examples of grooving, etc., both on the sides and

floor of the rocky knoll. All the sides of the hills to the east from Lake Dora leading down to the valley of King River, are abundantly planed, scored, striated, and polished, the latter especially where the beds consist of quartzite rock; even to the top of the hills, some 300 feet above the level of the lake and on the east side, these features extend, striations and polished surfaces occurring to the very crest of the hills. By means of the striæ it is easy to see the direction in which the ice mass moved, for the great glaciers, which at Lake Dora must have been at least 400 or 500 feet thick, moved continually outwards from where the accumulation of ice was greatest. Studded as this ice was with small and great angular blocks of conglomerate, etc., it resembled a huge rasp, which, with irresistible force, filed down, rounded off, planed and scored the surfaces they came in contact with, and also registered in a most durable manner the course in which they were travelling. About Lake Dora the striæ point in many different directions, and it appears as though over this tract there must have been a very thick covering, the pressure of the great mass above compelling the ice to travel in different directions, even up the sides of hills, for the hills on the east side of Lake Dora are striated and scored up steep faces in the direction of their crests and over their summits.

About the best example of what such a great ice-rasp can accomplish is shown at Moore's Shoulder, named after my friend, Mr. T. Moore, who was my comrade and guide in this wild region. At this site a great glacier throughout a vast period must have been deflected around this projecting angle of rock; the result is marvellous, for the intensely hard Devonian conglomerate has been planed, rounded, scored, and polished in a manner that baffles description; the ice marks are noticeable high up the hill sides. Probably at this point the ice was of great thickness, in fact it appears from the scorings, etc., that a great volume of ice hundreds of feet thick covered the whole of this elevated region.

The bed-rock over this region showing such abrasions, etc., it is natural to expect that the moving blocks and boulders which, set in ice, formed the teeth of the rasp, should also equally bear evidence of the work they did, and such is abundantly present, for a large proportion of both great and small rocks and boulders in the moraines are ground down, striated, or otherwise bear

testimony to the forces they have been subjected to. Many of the small pebbles detached from the blocks of Devonian or schistose conglomerates are remarkably ground down, polished, or striated. Some of the pebbles from the Devonian conglomerate are sheared in a remarkable manner; this was done while in their parent mass, the glacial markings have been added since. Curiously enough, at Prince Albert, in Cape Colony, sheared pebbles of precisely similar character occur in the older glacial conglomerate (Dwyka conglomerate) of that region that also show glacial markings, and they, too, are derived from a conglomerate of supposed Devonian age.

Tarns.

Lakelets from several miles in length down to mere ponds are met with throughout these highlands; they occupy rock-basins that the ice mass ground out where the bed-rock happened to be softer than usual. It is noticable that many of these basins have the longer axis in the direction of the strike of the rock, and they appear to occur most frequently on schist country. Nowhere do these tarns appear to be more than a few feet deep, they occur at many different altitudes. The outlets are sometimes over bare bed-rock, in other cases morainal matter dams the water back. Small rocky islets dot some of the tarns, and on them and around the edges of some of the tarns ti-tree and other small trees grow, greatly enhancing their beauty. Now that the flexibility of ice masses is well understood it is easy to understand how such rocky basins could be eroded.

Extent of Glacial Action.

It appears highly probable that the central highlands around Lake St. Clair, and in fact the greater portion of the island above the 2,000 feet level should also contain evidences of glacial action if searched for, and remains in abundance may be expected in the higher country east of Lake Dora.

Age.

There are no direct evidences by which the age of this glaciation can be determined; so far as the appearance of the moraine,

erratic blocks and scored and planed surfaces go, it might have taken place only a few years ago; in some places where the peaty material can be stripped off the abraded surfaces, the face of the rock is as fresh-looking as though the work had been done but yesterday. I do not consider this glaciation could have been older than of tertiary date, and it may very well be recent in age.

Glacial Conglomerate.

Quite distinct in character from the above, and differing entirely in age, origin, and method of deposit, is a remarkable conglomerate that occurs on the south side of the track between Mt. Reid and Moore's Pimple, and about equidistant from each; the site is marked by a shallow hole, and it is 3,000 feet above sea level, high above the observed morainal deposits, etc. The conglomerate consists of a great variety of sandstones, igneous rocks, shales, etc., nearly all well rounded and also beautifully striated; the pebbles and boulders are of non-local origin, unlike the morainal matter above described, and it rests upon Devonian sandstones. There is a marked similarity in the nature of the cementing material, and in the character of the embedded pebbles and boulders, to the glacial conglomerate found at Wild Duck Creek, Victoria, and to the Dwyka congolmerate of South Africa, and they probably all belong to a very ancient epoch, either near the close of the Palæozoic period, or else the commencement of the secondary era. This particular outcrop is, apparently, of no great thickness, and not very extensive, but further search should discover more such outcrops, and their relations might eventually be determined as regards the older Devonian series, and also the more recently accumulated rocks.